3.111

3.111 The flowrate in a water channel is sometimes determined by use of a device called a Venturi flume. As shown in Fig. P3.111, this device consists simply of a hump on the bottom of the channel. If the water surface dips a distance of 0.07 m for the conditions shown, what is the flowrate per width of the channel? Assume the velocity is uniform and viscous effects are negligible.

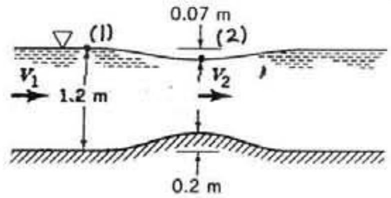

FIGURE P3.111

$$\frac{p_1}{\gamma}+\frac{V_1^2}{2g}+z_1=\frac{p_2}{\gamma}+\frac{V_2^2}{2g}+z_2 \quad \text{with } p_1=0,\ p_2=0,\ z_1=1.2\,m, \qquad (1)$$
$$\text{and } z_2 = 1.2\,m - 0.07\,m = 1.13\,m$$

Also, $A_1V_1 = A_2V_2$

or

$$V_2=\frac{h_1}{h_2}V_1=\frac{1.2\,m\ \ V_1}{(1.2-0.07-0.2)\,m}=1.29\,V_1$$

Thus, from Eq. (1):

$$\frac{V_1^2}{2g}+z_1=\frac{V_2^2}{2g}+z_2 \quad \text{or } \left[(1.29)^2-1\right]V_1^2=2\left(9.81\,\frac{m}{s^2}\right)(1.2-1.13)\,m$$
$$\text{or } V_1 = 1.438\,\frac{m}{s}$$

Hence,

$$q=h_1V_1=\left(1.438\,\frac{m}{s}\right)(1.2\,m)=\underline{\underline{1.73\,\frac{m^2}{s}}}$$